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ECONOMIC RESEARCH AID

METHODOLOGY FOR ESTIMATING SOVIET PRODUCTION CAPACITY FOR STANDARD CARGO SHIPS

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FOREWORD

Many intelligence problems require estimates of the shipbuilding capacity of the USSR. This research aid develops for production of standard cargo ships several alternative methods for estimating the capacities of Soviet shipyards, and these methods take into account the various types of data that may be available.

CONTENTS

Appendixes

Charts

METHODOLOGY FOR ESTIMATING SOVIET PRODUCTION CAPACITY FOR STANDARD CARGO SHIPS*

Summary

The quantity of available reliable information on facilities in Soviet shipyards varies considerably, and there is both a wide range in types of ships produced by Soviet shipyards and a wide range in the capability** of Soviet shipyards. Because of the variety of ships and shipyards and the varying amounts of information available on shipyard facilities, four different methods have been developed for estimating capacity*** for producing ships based on production of standard cargo ships. These methods are based also on the following selected factors that have a limiting effect on production: floor and working area, size and arrangement of ship erection sites,† hull steel fabrication and subassembly area, and total shipyard area. Usually some information is available on one or more of these factors.

I. Introduction

The shipbuilding industry of the USSR constitutes a relatively small sector of the industrial economy. The importance of this sector, however, is in its contribution to the Soviet national defense in the form of naval ships and to the Soviet foreign and domestic commerce in the form of commercial ships for oceangoing, coastal, and inland waterways service. Because of the importance of ships both to national defense and to the national economy of the USSR, it is necessary to examine the capability of the shipbuilding industry to produce ships.

* The estimates and conclusions in this research aid represent the best judgment of this Office as of 1 June 1960. The methodology described in this research aid is considered to be applicable to the current level of shipbuilding technology in the USSR. Future improvement in technology may change the values used. For a discussion of the term standard cargo ship as used in this research aid, see Appendix A.

** The term capability as used in this research aid refers to the technological ability to produce ships of various types.

*** For a discussion of the term capacity as used in this research aid, see II, 2, p. 5, below.

† For a discussion of the terms ship erection site and subassembly as used in this research aid, see III, 2, p. 9, below.

The Soviet shipbuilding industry is divided into two separate major divisions. The first division produces materials such as steel plates, shapes, and castings and components such as electronic devices and machinery. Although many major Soviet shipyards produce some components such as steam boilers and castings, most components are produced by industrial plants scattered throughout the USSR. The second division fabricates steel plates and shapes and assembles them to form the ship's hull and assembles and installs electronic and machinery components to form the completed ship. This second division requires shipyards, and these shipyards are located on the navigable waters of the USSR. Geographic, defense, and economic factors influence the distribution of shipyards.

Because the principal limiting factor in production of ships is the shipyard, it is the second division, or the capability of shipyards to produce ships, that is examined in this research aid.

The demand for ships in the USSR covers a wide variety ranging in size and type from small shallow-draft cutters of a few tons and horsepower to large oceangoing merchant ships and large combatant ships for the Soviet Navy. To develop the capability to meet this demand after World War II, the USSR built new shipyards, re-equipped and expanded old ones, and developed an extensive industry for building ship components.

Because of the wide range in types and sizes of ships and the volume of standardized classes, shipyards have been developed to some extent for the specialized construction of single types. For example, Petrozavodsk Shipyard No. 789 appears to have been designed for the construction of wooden ships that are the size of small trawlers, Sudomekh Shipyard No. 196 in Leningrad was designed principally for the assembly of submarines, and Zhdanov Shipyard No. 190 in Leningrad and Northern Shipyard No. 445 in Nikolayev were designed for the construction of destroyers. Although other ships have been built in each of these shipyards, facility layout and equipment is most suitable for the maximum production of the types of ships mentioned.

Other shipyards build a variety of ships. Examples of this group are Krasnoye Sormovo Shipyard No. 112 in Gor'kiy, Nosenko Shipyard No. 444 in Nikolayev, and Baltic Shipyard No. 189 in Leningrad. Krasnoye Sormovo Shipyard builds self-propelled and non-self-propelled river ships of all types, dredgers, tankers for the Caspian Sea, and submarines for the Soviet Navy. The Nosenko and Baltic Shipyards build ships for the river and fishing fleets, the maritime fleet, and submarines and large combatant ships for the Soviet Navy.

Particularly since World War II, capital investment in the shipbuilding industry has been allocated principally to shipyards that build ships of high priority. As a consequence, there is a wide range in the capability of shipyards. With the recent lessening of the demand for naval ships, greater investments are being made in shipyards that heretofore built only ships of lower priority.

Because of the wide ranges in types of ships and in the capability of shipyards, any estimates of shipbuilding capacity are subject to wide margins of uncertainty. In this connection, the discussions of shipbuilding capacity in The Economist, London, 2 June 1956, and by A.S. Kreps in Ekonomika sudostroitel'noy promyshlennosti (Economics of the Shipbuilding Industry), Leningrad, 1955, are of considerable interest.

The article in The Economist points out that in 1921, at the peak of the boom after World War I, the UK had 3.6 million gross tons* of ships under construction in its shipyards and the "capacity" of the industry was put at 3 million gross tons. Ship launching, however, never exceeded the 2.1 million gross tons launched in 1920. The "capacity" of the modernized industry at the end of World War II again was put at 3 million gross tons, but during the postwar boom it never exceeded the 1.5 million gross tons launched in 1955. Although steel and labor have been limiting factors since World War II, the effective capacity lies somewhere between 1.5 million and 2 million gross tons per year.

In comparison, the US in 1943, at the peak of the war effort, turned out about 11.5 million gross tons, which was far in excess of estimates of capacity and about twice as much as all of the rest of the world's shipyards produced in 1956.

The article from Kreps's book deals with the factors that are to be considered in the measurement of the capacity of a shipbuilding enterprise for purposes of production planning.

The quantity of available reliable information on facilities in Soviet shipyards varies considerably. Shipyards that have been engaged in naval shipbuilding and are located in remote regions are not observed or mentioned in the Soviet press -- for example, Severodvinsk Shipyard No. 402 and Shipyard No. 820 at Kaliningrad. Other shipyards, however, like Shipyard No. 102 at Kherson and Krasnaya Kuznitsa Shipyard at Kiev, which have been engaged in construction of merchant ships, are displayed in scale model form at official Soviet exhibits.

* Tonnages are given in long tons (2,240 pounds) throughout this research aid.

Shipyards in Leningrad, although engaged in construction of naval ships, are observed by travelers entering and departing the USSR and visiting Leningrad.

Because of the variety of ships and shipyards and the varying amounts of information available on shipyard facilities, a method of estimating production capacity of shipyards for purposes of comparison is best based on production of a single type of ship. Standard cargo ships were selected because of the availability of some data on their production and because they are generally accepted as a basis for estimating costs and rates of production of ships. Data have been compiled on cargo ships ranging from 250 to 10,000 LSD.* The selection of a ship size to be used in estimating the production capacity of a single shipyard is based on the size of the ship erection site and the layout of the shipyard.

II. Definition of Unit of Output and Capacity

1. Unit of Output

To facilitate determination of the capacity of a shipyard, it is necessary to establish a standard unit of output. Although not entirely satisfactory, the unit of output used in this research aid is a light ship displacement ton. After careful consideration of the many widely used units for measuring the size of a ship, this unit was selected as the unit yielding the minimum error in the determination of the amount of labor, cost, and materials.

Methods used by the US Navy, industry, and commerce to measure the size of a ship or to measure output of a shipyard suggested several possible standard units of output. The advantages and disadvantages of each of these are discussed below.

First, consider output in terms of completed ships or marketable product. The index of marketable product for a shipyard fluctuates greatly. The time required to build ships of various types, ranging from a few weeks for a non-self-propelled river barge to several years for a navy cruiser, together with weather conditions that may affect delivery dates of completed ships, produces a highly erratic index curve for the marketable product. For example, the average time required to construct a Kazbek-class tanker is about 15 months from keel laying to delivery, not including several months lead time before keel laying. A tanker begun in the last quarter of a year would not show in statistics on production by a shipyard until 2 years later. The curve

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* LSD (light ship displacement) is the weight (in long tons) of a ship complete, ready for service in every respect, including permanent ballast (solid and liquid) and liquids in the machinery at operating levels but excluding the crew and their effects and all items of consumable or variable load such as stores, fuel, and cargo.

for the marketable product, therefore, reflects accurately neither input of resources by the shipyard nor rate of production.

A second possible method for measuring the amount of output by a shipyard is stages of customer payment. Contracts of shipyards with shipowners for ships that are under construction more than a few months provide for partial monetary payments on the completion of a fixed part of the ship. Final payment is made on completion of the ship and the satisfactory performance of all tests and trials. This practice of stages of payment is used also in the USSR. Because payments are made only on satisfactory completion of a stage of construction, the shipyard is required to use its own working capital to finance each stage of construction. It is readily apparent that each payment and, in particular, the final payment for a large ship lags by a considerable period of time the actual expenditure of resources by a shipyard.

For operational purposes, different methods for measuring ships are used. For naval ships, data of various predetermined conditions of loading are required, and for merchant ships both volumetric and loading measurements are used. Because neither volume nor loading measurements reflect the magnitude of expenditure of resources in the construction of ships, they are not desirable for measuring the annual output of a shipyard.

2. Capacity

The term capacity as used in this research aid means the annual total number of units of output of standard cargo ships that are produced by a shipyard at the maximum rate and that are of a size best suited to the production facilities of the shipyard. It is assumed that, for each shipyard, there will be an uninterrupted flow of material; that there will be adequate supervisory, skilled, and unskilled personnel; and that there will be adequate power and transportation. Work is organized on a three-shift basis, and direct labor is distributed, by shifts, in the order of 60 percent on the first shift, 30 percent on the second shift, and 10 percent on the third shift.* Because of the large number of covered and heated ship erection sites in the USSR, no weather factor is used to adjust estimates of capacity production.

Although only the maximum rate of production is considered in this research aid, it is of interest and may be of considerable value in economic studies of the shipbuilding industry to examine a second, or optimum, rate of production.**

The maximum rate is, as the name implies, the highest possible production of ships for which the shipyard was designed or has had the

* See Appendix C.
** For construction time of standard cargo ships at both rates, see the chart, Figure 8, following p. 18.

greatest production experience, without consideration of costs. US data indicate that, under a maximum rate of production, labor efficiency falls to 0.87 when a factor of 1.0 for the optimum rate is used and that the maximum rate of production is about 1.7 times the optimum rate.

The optimum, or most favorable, rate is one in which employment of labor in relation to shipyard facilities achieves the highest efficiency of labor in producing ships for which the shipyard was designed or has had the greatest production experience. US data indicate that this level is achieved when employment is about 50 to 60 percent of maximum possible employment. The optimum level is also the point of lowest cost of production per unit.

III. Principal Methods for Measuring Capacity

On the basis of the probability that certain information will be available on shipyards of the USSR, four methods for calculating maximum capacity on the basis of a single shipyard have been developed.

These four methods employ and combine both the physical properties of the shipyard and labor productivity. The first method is based on the relationship of floor and working area to maximum output; the second, on the relationship of methods, time, and ship erection sites to maximum output; the third, on the relationship of hull steel fabrication and subassembly area to maximum output; and the fourth, on the relationship of total shipyard area to maximum output. These methods may be used also to check reported rates of production, but in any event they are to be used only as alternatives to proved data on production. They are applicable to only two types of shipbuilding enterprises (the yard and the shipbuilding - machine-building plant*) and to the assembly yard and delivery base type of enterprise. Two examples showing the practical application of each of the four methods are found in Appendix B.

Several different methods for building ships are used in the USSR. Generally the same basic procedure is followed in each shipyard in the preparation and fabrication of steel plates and shapes and in assembly and testing of machinery. The principal differences lie in the manner in which the hull and superstructure are assembled and in which machinery is installed. The practice of building sections of a ship, whether they are subassemblies or structural regions,** and then joining these sections together on a ship erection site has resulted in

* For the classification of these enterprises, see Appendix C.
** For a discussion of the term structural region as used in this research aid, see 2, p. 9, below.

greater production from each erection site, reduced total man-hours, and a better quality of work.

An understanding of the procedure used in each shipyard under study is necessary to the successful use of the several methods for calculating maximum capacity. Figures 1 and 2* are diagrams showing the principal methods that are used. Variations in the material flow and methods are to be found among shipyards in the USSR. These variations may result from shipyard layout or from the type of ship being built.

The methodological charts, Figures 3 through 9,** were developed to show averaged data and are used throughout this research aid as part of the methodology. When reliable specific data are available, however, the data should be used in preference to the charts. For two examples of use of these data, see the discussion of Shipyard No. 102 at Kherson and the Krasnaya Kuznitsa Shipyard at Kiev in Appendix B.

1. Relationship of Floor and Working Area to Maximum Output

Shipbuilding capacity that is calculated on the basis of the relationship of floor and working area to maximum output is subject to minimum error when applied to enterprises that are strictly of the yard type. When applied to enterprises of the shipbuilding - machine-building type, shipbuilding capacity may be overstated. The amount of error will increase according to the increase in floor area allocated to machine-building or other manufacturing facilities in the enterprise.

The maximum annual output of a shipyard based on the floor and working area can be estimated by using the following formula:

$$P = \frac{\frac{A_F}{A_{FW}}\left(\frac{W_D}{W_T}\right)}{0.60}\left(W_{DL}\right)$$

* Following p. 8.
** Appendix A, following p. 18.

where the symbols have the following meanings and are calculated as follows:

P equals the total maximum annual output in light ship displacement for three-shift operation.

A_F equals the total floor area in square feet of all buildings in the shipyard, including all shops, administrative buildings, utility buildings, covered storage areas, and the like and the working area of open platen or subassembly areas, ship erection sites, and fitting-out quays but excluding open storage area. The effective area of the ship erection sites and quays is calculated by multiplying the length of the sites and fitting-out quays by the width of the practical maximum size (length over-all) ship that the shipyard can build. The practical maximum size of ship that a shipyard can build is a judgment factor based on shipyard facilities and shipbuilding techniques.

A_{FW} equals the working area in square feet required by one person. From Figure 3 select the number of square feet applicable to the size of ship selected for A_F , above.

The factor $\frac{A_F}{A_{FW}}$ is the maximum number of employees (direct and indirect*) that can be employed on one shift.

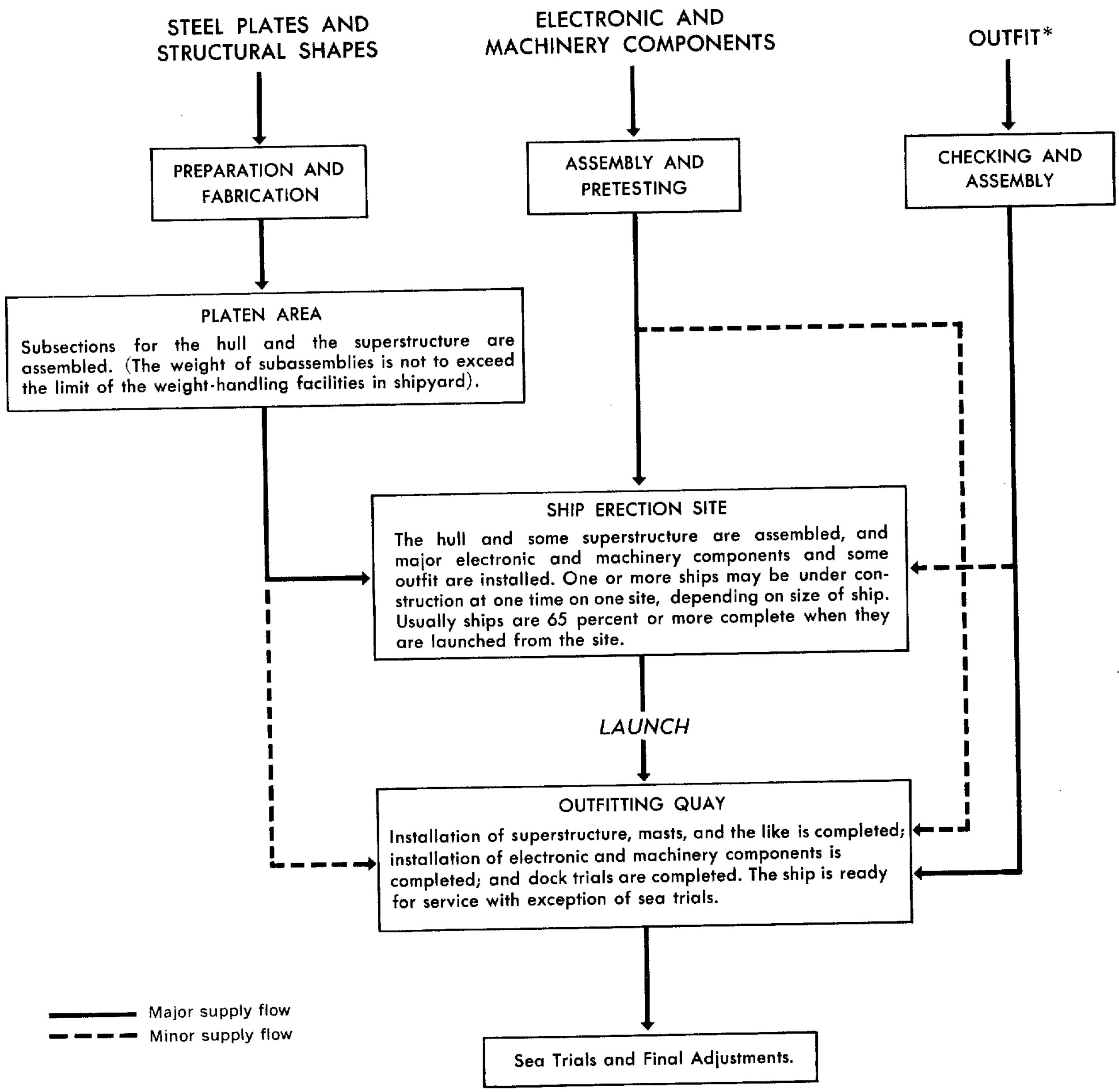
$\frac{W_D}{W_T}$ equals the percentage of direct workers. This percentage will vary from 75 to 90 percent of total employment depending on the size and operation of the shipyard.** Most shipyards will operate at 75 percent. The factor

$\frac{A_F}{A_{FW}}\left(\frac{W_D}{W_T}\right)$ is the total number of direct workers on one shift. If a three-shift operation is assumed with

* For a discussion of the terms direct employees and indirect employees, see Appendix C.
** See Appendix C.

Figure 1

USSR: Flow of Material in Shipyards That Assemble Ships on Ship Erection Sites from Subassemblies



*The term outfit as used in this chart comprises masts, booms, deck gear, navigational equipment, furniture, furnishings, hotel equipment, and the like.

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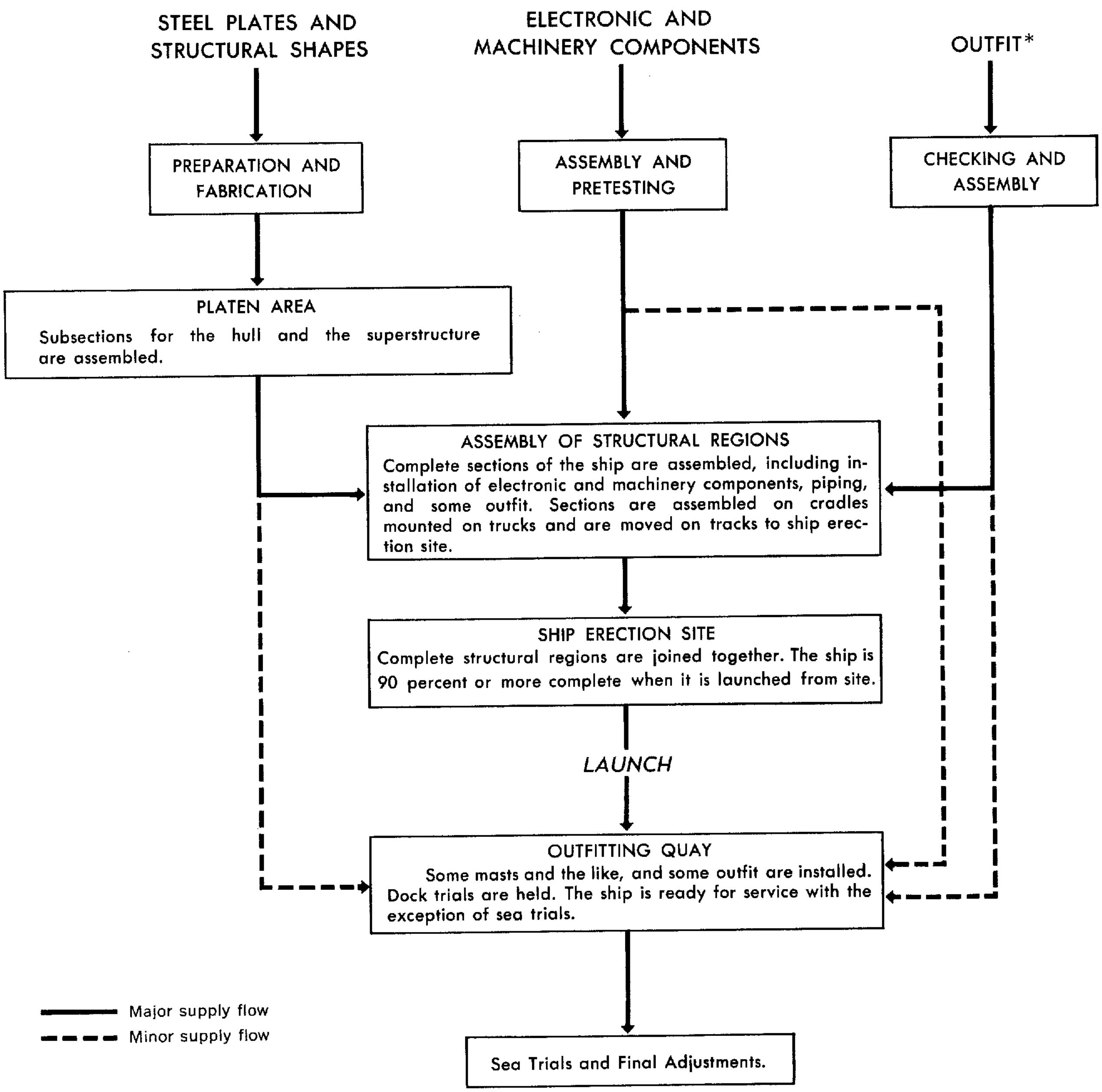
Figure 2

USSR: Flow of Material in Shipyards That Assemble Ships on Ship Erection Sites from Preassembled Structural Regions



*The term outfit as used in this chart comprises masts, booms, deck gear, navigational equipment, furniture, furnishings, hotel equipment, and the like.

29002 7-60

28 JUL 1960

MEMORANDUM FOR: Chief, Analysis Branch, DD/CR

ATTENTION 25X1A9a : [redacted], DD/AB/SS

FROM : Chief, Publications Staff, ORR

SUBJECT : Release of CIA/RR A.ERA 60-5, Average Annual Money Earnings of Workers and Employees in the USSR, 1928-65, June 1960, FOR OFFICIAL USE ONLY

1. It is requested that the attached copies of subject report be forwarded as follows:

25X1X7

43 - 46 [redacted] (transmitted via SA/RR)
47
48 - 50
51 AFCIN 25X1X7
52 - 53
54
55 [redacted]

2. All ORR responsibilities as defined in the DDI memorandum of 13 August 1952, "Procedures for Dissemination of Finished Intelligence to Foreign Governments," as applicable to this report, have been fulfilled.

25X1A9a

[redacted]

11 Attachments

60 percent of the direct workers on the first shift, 30 percent on the second shift, and 10 percent on the third shift,

the factor $\dfrac{\dfrac{A_F}{A_{FW}}\left(\dfrac{W_D}{W_T}\right)}{0.60}$ is the total number of direct workers

for the three shifts.

W_{DL} equals output in light ship displacement per direct worker per year. From Figure 4 determine the weight in light ship displacement of the ship selected to be built in the shipyard. From Figure 5 determine the light ship displacement that can be produced per direct worker per year (which will be the factor W_{DL}) for ships of this size.

2. Relationship of Methods, Time, and Ship Erection Sites to Maximum Output

With the exception of instances in which sections of ships are transferred over land or sea to a remote shipyard for final assembly, all ships produced by a shipyard are finally assembled on a ship erection site* usually located within the shipyard.

As a result of the introduction of welding and other technological improvements, ship assembly methods have changed drastically. The actual erection time on the final erection site has been greatly reduced. Capital improvements in some of the older shipyards in the US and foreign countries have reduced the number of ship erection sites, and some of the sites that were retained have been enlarged, whereas the abandoned sites have been converted to areas for the preassembly of ship sections.

In this method for calculating maximum output, the number of ship erection sites, the maximum length of ship that can be built, the question of whether ships are assembled from subassemblies or structural regions,** and the required construction time are the principal

* The term ship erection site denotes a facility on which a ship is assembled.

** Two principal forms of preassembled ship sections are used in the assembly of ships on an erection site, a subassembly and a structural region. A subassembly is an individual portion of the ship construction, which is first assembled outside the /footnote continued on p. 10/

factors to be considered. The time required to construct a ship is that period of time from the start of the assembly of the ship on a ship erection site or from the start of the assembly of the structural regions to the delivery of the ship after satisfactory conclusion of all tests and trials. It should be noted that the assembly of the structural regions usually takes place outside the ship erection site. Figure 8 shows the estimated average construction time required in the USSR for two conditions of employment.

The time required to assemble a ship on an erection site varies according to the layout of the shipyard and the extent to which preassembled ship sections are used.

Shipyards in the USSR that build large ships assemble the ships on a ship erection site from large subassemblies. The sizes of these subassemblies are limited by the weight-handling facilities in the shipyard. Some shipyards in the USSR that build small ships join together complete structural regions to form a completed ship, thereby requiring only a matter of days or a few weeks to erect a ship on the ship erection site.

It is important that the whole assembly process of a ship be examined beginning with the completion of hull steel subassemblies. These subassemblies usually are moved either directly to the erection site or to the area for the assembly of structural regions. In instances in which the subassemblies are moved directly to the ship erection site, the position on the erection site where these subassemblies are joined together is considered the first building position of the ship. When the subassemblies are moved directly to the area where the structural regions are assembled, this area is considered the first building position of the ship. A ship usually moves through three or more building positions before completion.

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ship and is delivered as a unit by cranes or other lifting devices to the ship erection site -- for example, the shell plating subassembly with its framing, a section of a deck or bulkhead with structural stiffeners attached, a piping subassembly with fittings, and the like.

A structural region, compared with a subassembly, is a portion of a ship usually bounded at each end only by vertical transverse planes running through the entire height of the ship and on the sides, bottom, and top by shell plating and decks. A structural region is assembled outside the ship erection site from individual subassemblies and contains machinery, piping, insulation, and compartment furnishings. Structural regions are assembled and moved to the ship erection sites on carriages mounted on rails. Because of size and weight, generally the use of structural regions in the assembly of ships is restricted to smaller ships.

Because different methods are used in the USSR to erect ships, a varying number of building positions is used. The time spent on the erection site represents only a portion of the total building time. It is this time, however, that determines the production rate for the shipyard. See Appendix C for examples showing the principal methods used in the USSR for erecting ships.

The following steps are to be followed to estimate maximum annual output of ships on the basis of the relationship of methods, time, and ship erection sites of a shipyard to maximum output. First, determine the maximum size of ship that can be built at the shipyard, the number of ship erection sites, the techniques used in ship erection (the extent of the use of subassemblies or ship regions), and the number of building positions that each ship moves through. Second, determine from Figure 4 the light ship displacement of the ship. Third, determine from Figure 8 the average construction time in months (maximum employment) required to build the ship. Fourth, the maximum annual output of a shipyard can be estimated by using the following formula:

$$P = \frac{12N}{M_C} (E)\ L$$

where the symbols have the following meanings and are calculated as follows:

P equals the total maximum annual output in light ship displacement for three-shift operations.

12 equals the number of months in 1 year.

M_C equals the average construction time (maximum employment) in months that are required to build the ship. This quantity is determined from Figure 8.

N equals the number of building positions that the ship moves through during construction.

E equals the number of identical erection sites in the shipyard. A separate calculation is made for each erection site of a different size.

L equals the light ship displacement of the completed ship. This quantity is determined from Figure 4.

3. Relationship of Hull Steel Fabrication and Subassembly Area to Maximum Output

It is common practice for shipyards to receive hull steel in the form of flat plates and straight structural shapes. The flat plates are chemically or mechanically treated to remove rust and mill scale after which the plates are coated with a preservative. The treated plates then are moved to a fabrication shop where they are marked, cut, and shaped into suitable pieces for assembly into a ship's hull, decks, and houses. Structural shapes also are cut and shaped in the fabrication shop. These cut and shaped pieces are moved from the fabrication shop to a platen area where the pieces are joined together, principally by welding, into subassemblies. (The platen area may be either within the fabrication shop or entirely separate depending on the layout of the shipyard.) The size and weight of the subassemblies vary with the type of ship under construction and with the weight-handling facilities in the shipyard. Subassemblies range in weight from a few pounds to more than 100 tons. The great majority of subassemblies weigh less than 40 tons. A few of the larger shipyards, however, can handle sections weighing more than 100 tons.

The size of the area and the equipment used in marking, cutting, shaping, and assembling, therefore, is a limiting factor in production of ships. Consequently, an estimate of the shipbuilding capacity of a shipyard may be made by determining the maximum output of finished hull steel.

Shipbuilding capacity calculated by this method is subject to minimum error when applied to enterprises that are strictly of the yard type. When applied to enterprises that are of the shipbuilding - machine-building type, shipbuilding capacity may be overstated. The amount of error will increase according to the increase in floorspace allocated to steel fabrication and subassemblies for products other than ships.

The maximum annual output of a shipyard based on the area of the hull fabrication and subassembly area can be estimated by using the following formula:

$$P = \frac{A_H \left(A_{HL}\right)}{\left(\frac{H}{L}\right)}$$

where the symbols have the following meanings and are calculated as follows:

P equals the total maximum annual output in light ship displacement for three-shift operation.

A_H equals the area in square feet of the hull fabrication and subassembly area. Care should be taken not to include in the subassembly area any space used for the assembly of structural regions.

A_{HL} equals the tons of finished hull steel that can be produced per square foot per year. This factor is derived as follows: (a) estimate the maximum size of ship that can be built in the shipyard, and (b) from Figure 6 select the output rate based on the length of ship determined in (a), above. This rate then is A_{HL}.

$\frac{H}{L}$ equals the relationship of hull steel weight to light ship displacement in percentage. This factor is derived as follows: (a) From Figure 4 obtain the light ship displacement of the maximum size of ship that the shipyard can build, and (b) from Figure 7 obtain the percent factor that is applicable to the displacement of the ship determined in (a), above. This percentage is $\frac{H}{L}$.

4. Relationship of Total Shipyard Area to Maximum Output

Shipyard area varies considerably with the location of the shipyard and the industrial density of the surrounding area. Shipyards in Leningrad, where high industrial density exists, will have fewer square feet per person than at Shipyard No. 402 at Severodvinsk or Shipyard No. 199 at Komsomol'sk, where low industrial density surrounds the area and more space is available.

This method is subject to the greatest margin of error. In some instances this error may be in excess of plus or minus 50 percent. The method is included here because it is known that, in some instances, total area is the only information available.

The maximum annual output of a shipyard based on total shipyard area can be estimated by using the formula developed for method number 1 (relationship of floor and working area to maximum output) except that the value for the working area required by one person $\left(A_{FW}*\right)$ should read A_{TW} and is found in Figure 9.

5. Determination of Shipbuilding Capacity to Produce Naval Ships

Because of the wide range in types and classes of naval ships and a corresponding range in number of man-hours required to produce 1 LSD of each type or class, no meaningful single factor can be applied to data on capacity for cargo shipbuilding to convert them to capacity for naval shipbuilding.

To estimate capacity for production of naval ships, procedures similar to the four methods given in this research aid must be used except that separate charts will be required for each type of ship for Figures 5 through 8.

* See 1, p. 7, above.

APPENDIX A

METHODOLOGY

Shipyard facilities and technological development in many shipbuilding countries of the world vary considerably. Moreover, the range in types of ships is wide. Because most of the ships built in the world's shipyards are types of cargo ships, standard cargo ships were selected as a basis for all computations. The term standard cargo ship as used in this research aid refers to a ship designed for the transportation of general dry cargo, equipped with adequate cargo handling facilities, rigged with a propulsion system to provide average horsepower and speed consistent with the size of the ship, and fitted out to carry a normal crew and not more than 12 passengers. Because of the many variants that had to be considered in developing Figures 3 through 9,* no precise methodology can be stated. Data gathered from US or world statistics were arbitrarily adjusted to suit shipbuilding conditions, both economically and technologically, in the USSR. Arbitrary adjustment was done subjectively on the basis of many reports (documentary intelligence and raw and finished intelligence) on shipbuilding in the USSR and on a wide knowledge of methods and techniques of shipbuilding in the US.

1. Figure 3

The working area of a shipyard is considered to include the floor area in all covered buildings, multiple floors where they exist, outside subassembly areas, ship erection sites and fitting-out quays, and wharfs or piers. An arbitrary working area on a ship erection site is bounded by the length of the site and the width of the largest ship that can be built on the site. The working area of a fitting-out quay is bounded by the length of the quay and the width of the largest ship that can be built on the ship erection site.

The basic data used to establish the range shown in Figure 3 were derived from mobilization plans for US shipyards. These plans reported the shipyard and building areas and the maximum number of people that could be employed at one time. US data indicated a wide range in working area per man, ranging from 50 to more than 200 square feet (sq ft) per man, excluding shipbuilding ways, dry docks, and fitting-out quays. Shipyards engaged only in ship repair required the lowest number of square feet per man, whereas large shipyards engaged for the most part in shipbuilding required the greatest number of square feet per man.

* Following p. 18.

The working area required for shipbuilding alone did not vary as greatly as the range in working area of shipbuilding and ship repair shipyards would indicate. Working area seems to range from 150 sq ft per man for shipyards building small ships to 200 sq ft per man for shipyards building large ships. Thus working area seems to be influenced by the size of the ship that is being handled. This influence holds particularly true for hull fabrication. The maximum size of hull plate that steel mills produce can be used in a 400-ft ship. Therefore, no greater working area is required per man for the construction of larger ships. Plate sizes range downward in the smaller ships. Therefore, a smaller area per man is required.

2. Figure 4

The curve for the average relationship of length to tonnage was developed from a study of capacity plans of a good sampling of both US and foreign-built standard cargo ships with reported accommodations for less than 12 passengers.

3. Figure 5

The data that were used to develop the curve shown in Figure 5 were taken largely from B.M. Smirnov's Priblizhennyye metody opredeleniya stroitel'noy stoimosti morskikh gruzovykh sudov (Approximate Methods of Determining Construction Costs of Maritime Cargo Ships), Moscow, 1956. 1/* The rate of output per man fell somewhat below US data. It is believed, however, that the average rate is about 25 to 30 percent lower than the US rate. This lower rate was indicated also in A.S. Kreps's Ekonomika sudostroitel'noy promyshlennosti (Economics of the Shipbuilding Industry), Leningrad, 1955. 2/ An example of norm hours** to build a tanker of medium size is given by Kreps. It is believed that the basic data used in this example were obtained from production data on the Kazbek-class tankers. This example when compared with US data indicates a lower rate of production than the US and of about the same order as stated above.

4. Figure 6

The average annual output of finished hull steel per square foot of space varies according to the size and weight of the finished element.

The change in rate of output takes place between ships of 200 to 400 ft in length. Because ships that are 400 ft in length can use

* For serially numbered source references, see Appendix D.
** For a discussion of norm hours, see Appendix C.

the largest plate that rolling mills produce, there is no appreciable increase in output per square foot for ships of larger size. The range downward from ships of 400 ft to ships of 200 ft is caused largely by the following two factors: (a) the weight per square foot of the steel plate used decreases as the ship becomes smaller, and (b) the size of the subassembly also decreases as the size of the ship decreases. Therefore, the resulting output per square foot for the smaller ships is much lower than for larger ships.

The basic data used to establish the curve were derived from Smirnov's and Kreps's books, 3/ from a study of a new shipyard in Greece and two shipyards during World War II, and from some data from Baltic Shipyard No. 189 in Leningrad. The curve was arbitrarily adjusted downward to agree with reductions caused by changes in plate weights and in size and weights of subassemblies.

5. Figure 7

The basic data that were used to develop this curve were derived from studies of a good sampling of ships built by the US and from Smirnov's book. 4/

6. Figure 8

The basic data used to construct Figure 8 included a sampling of construction time required to produce standard cargo ships in selected US shipyards during World War II, mobilization data compiled by the US Maritime Administration of the Department of Commerce, and miscellaneous data on construction time for the Soviet Bloc.

It was of interest to note that the time required for Polish shipyards to construct ships for the USSR fell closely to curve A. Probably the best explanation for this is that Poland is forced to sell ships to the USSR at about world market prices. Poland therefore is forced to produce at the most economical rate in order to minimize losses.

7. Figure 9

Studies of total shipyard size were made at the same time that studies of working space (see Figure 3) were made. A space relationship similar to that for working area seemed to exist in total shipyard area. However, probably a greater limiting size factor of total shipyard area was the industrial density of the surrounding area.

Figure 3

Shipyard Floor and Working Area per Man

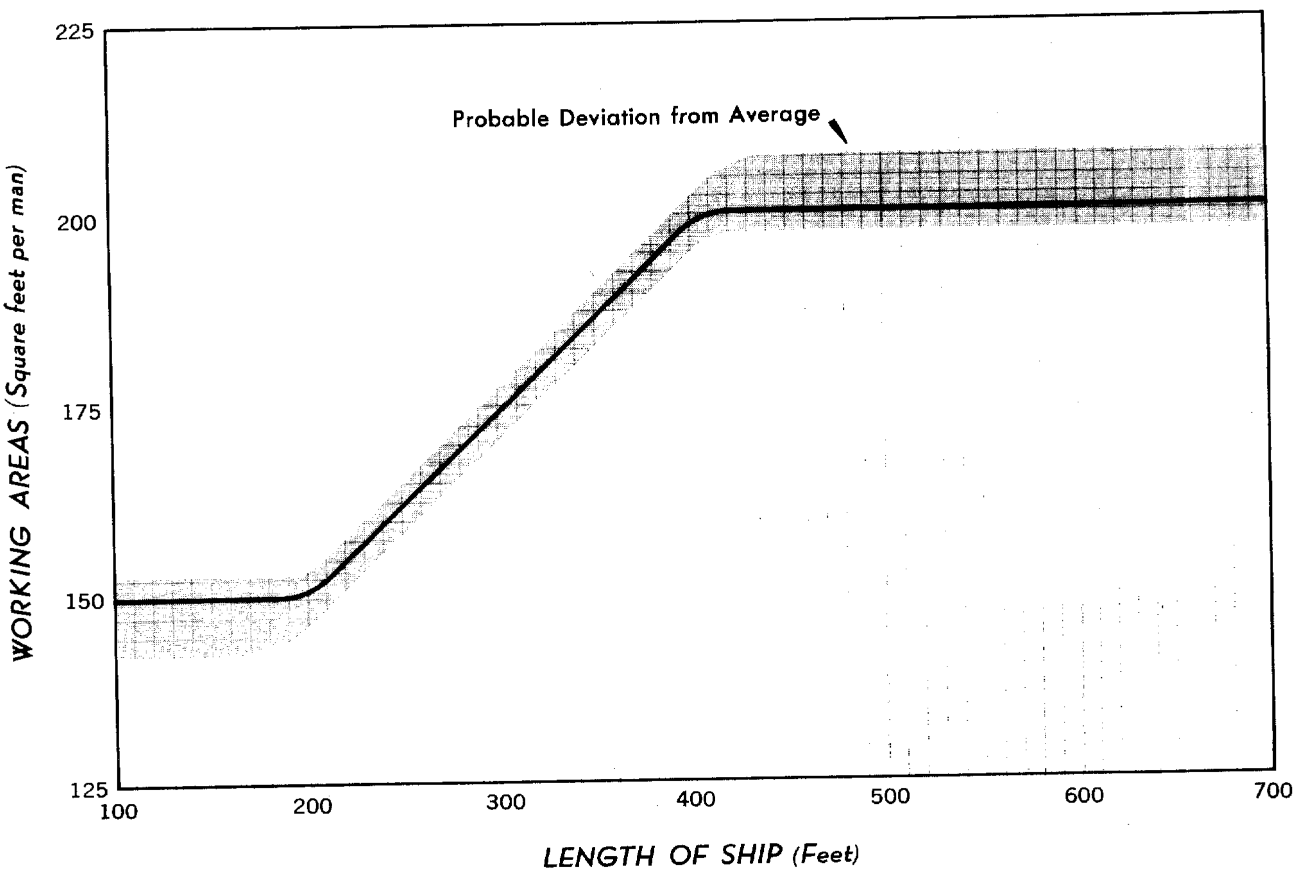

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Figure 3

Shipyard Floor and Working Area per Man

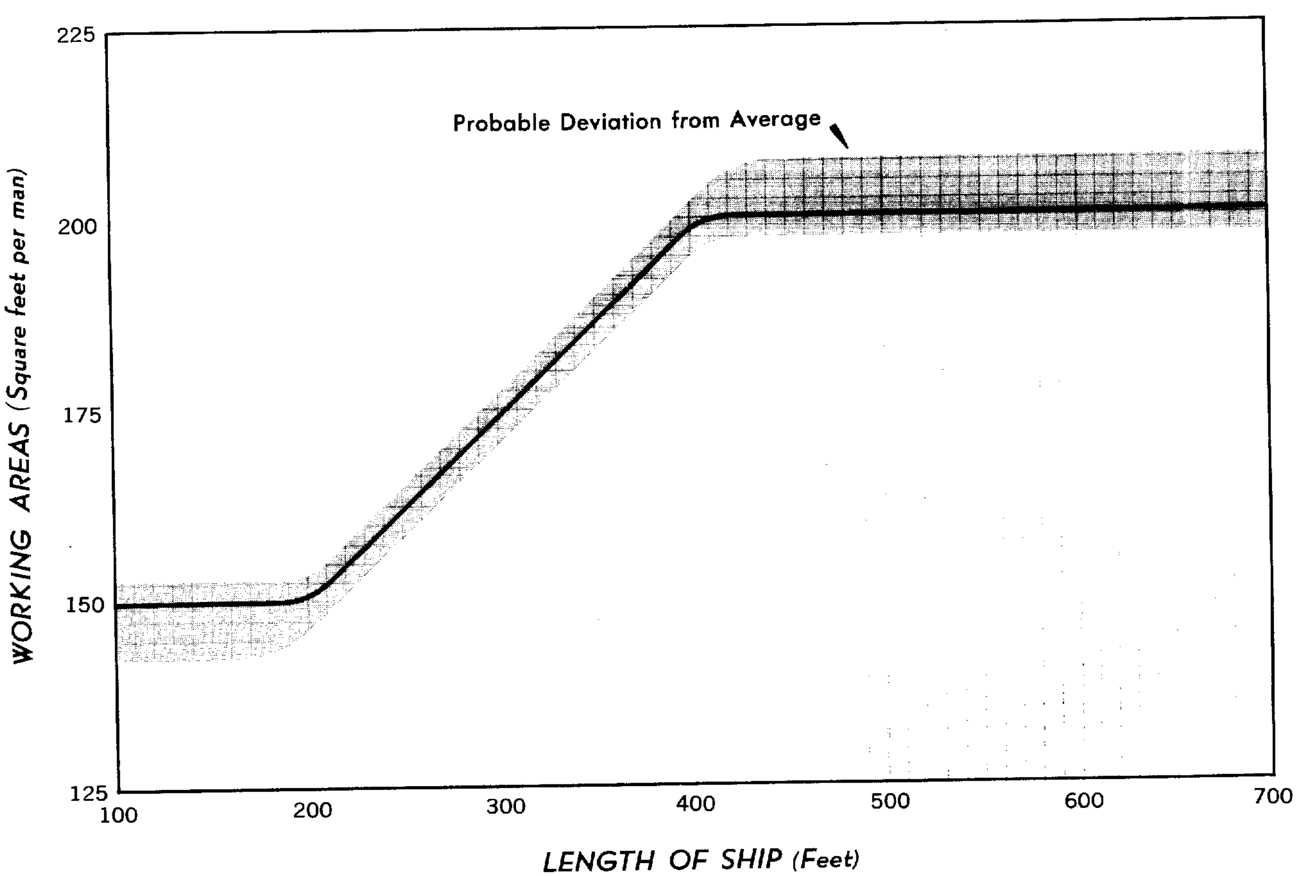

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Figure 4

Average relationship of Length to Light Ship Displacement for Standard Cargo Ships

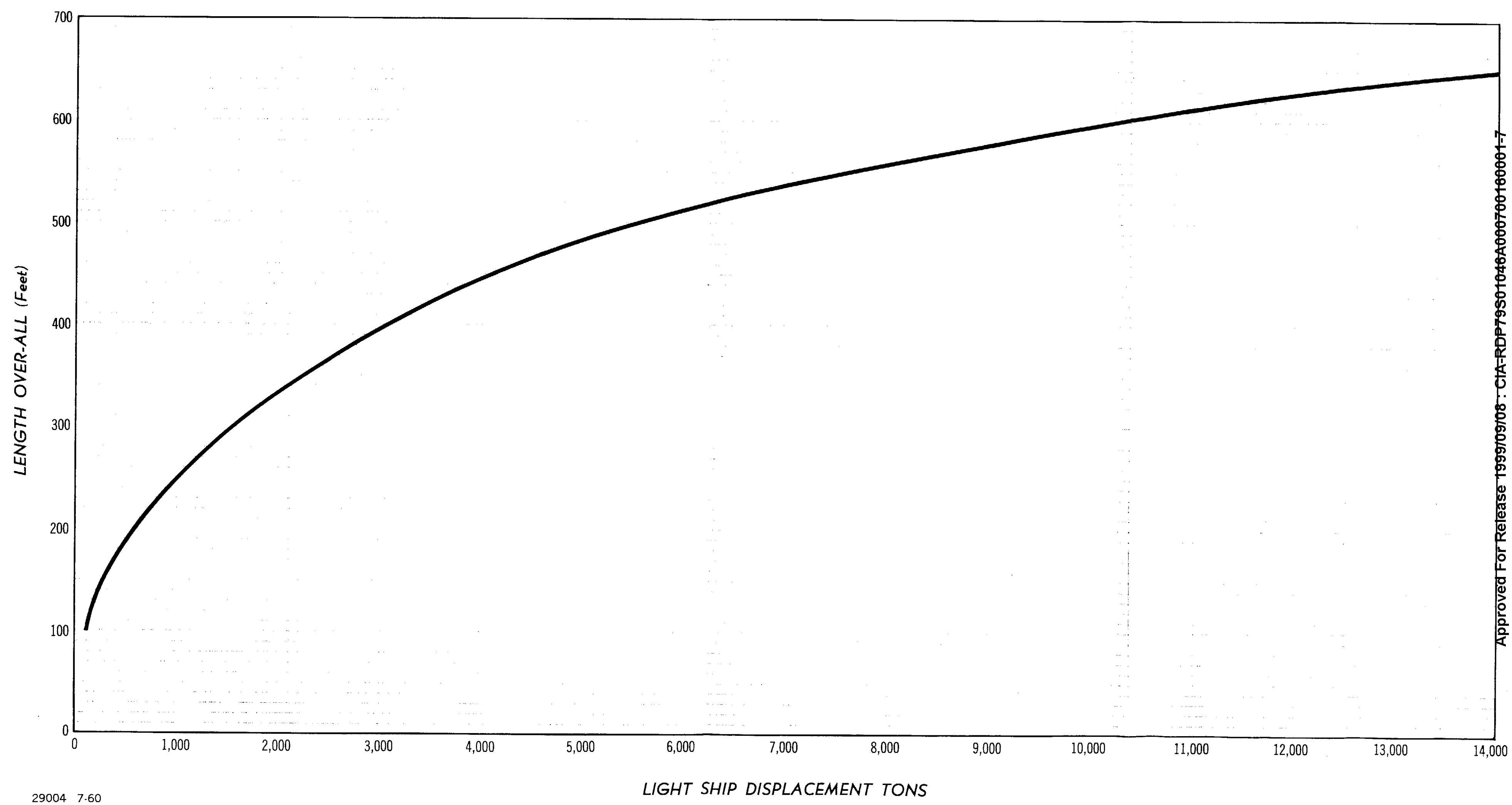

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Figure 5

USSR: Average Annual Output per Man per Year in Tons of Light Ship Displacement for Standard Cargo Ships

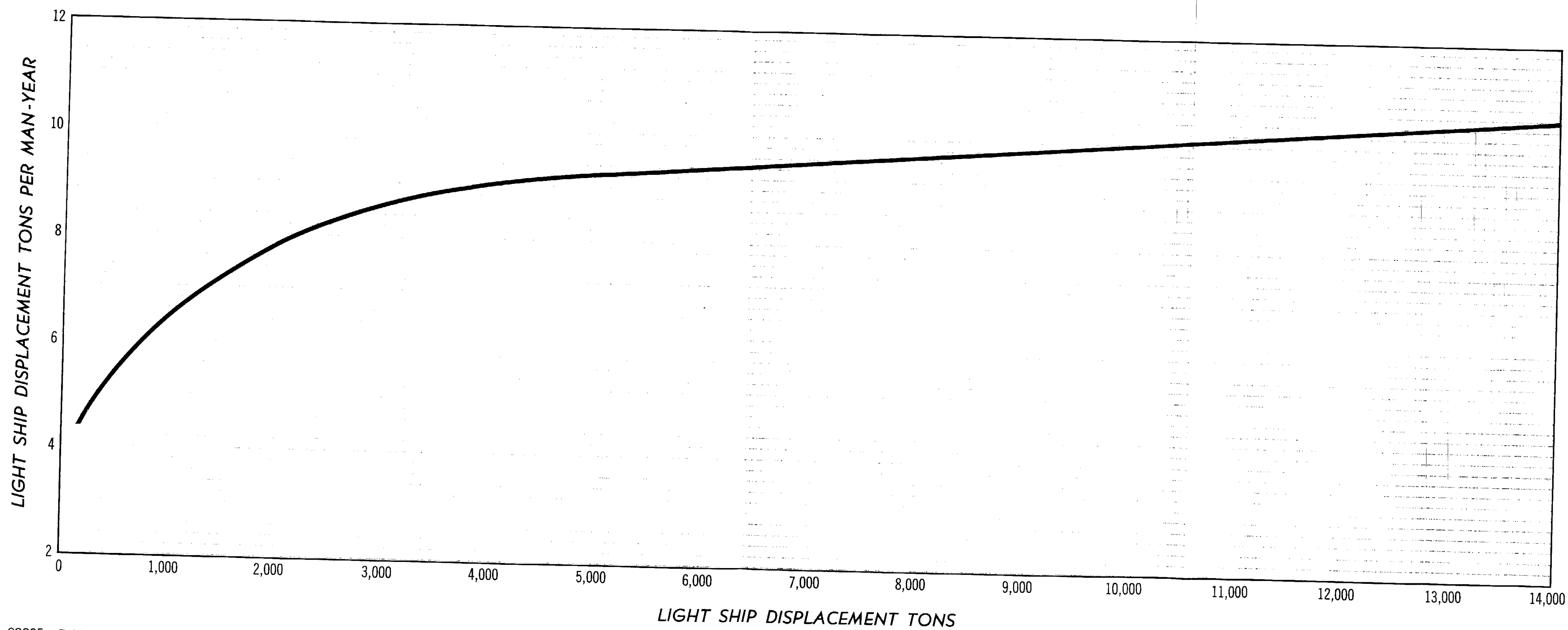

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Figure 6

USSR: Average Annual Output of Finished Hull Steel per Square Foot from Hull Fabrication and Subassembly Areas for Standard Cargo Ships

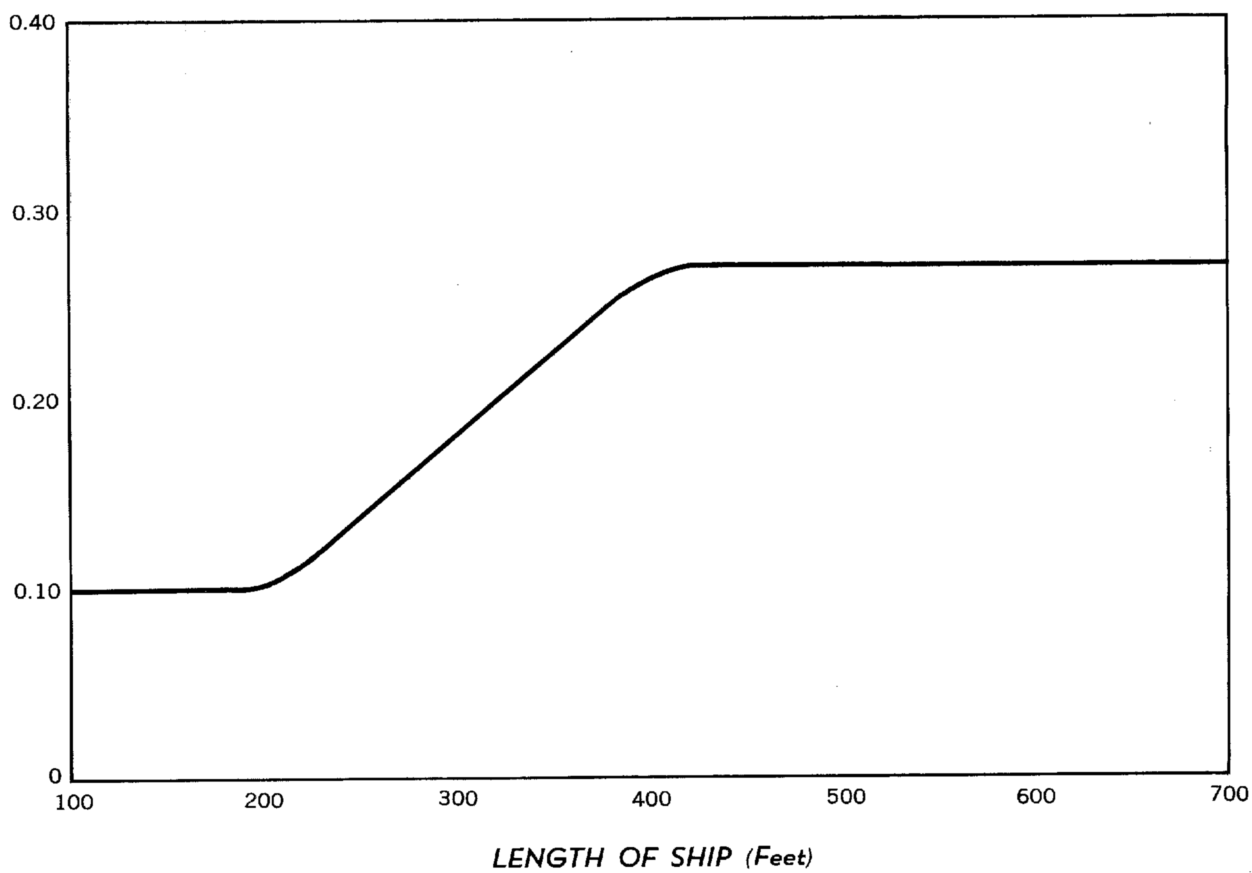

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Figure 7

Hull Steel Weight in Percent of Light Ship Displacement for Standard Cargo Ships

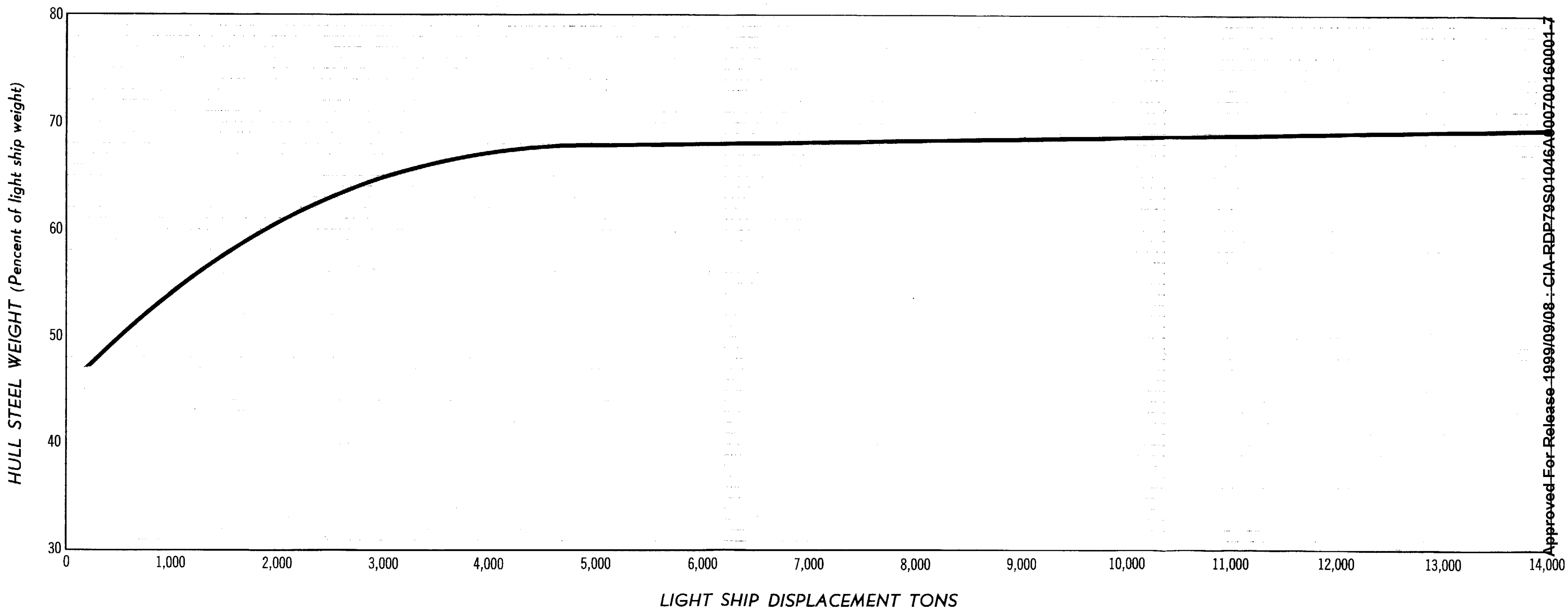

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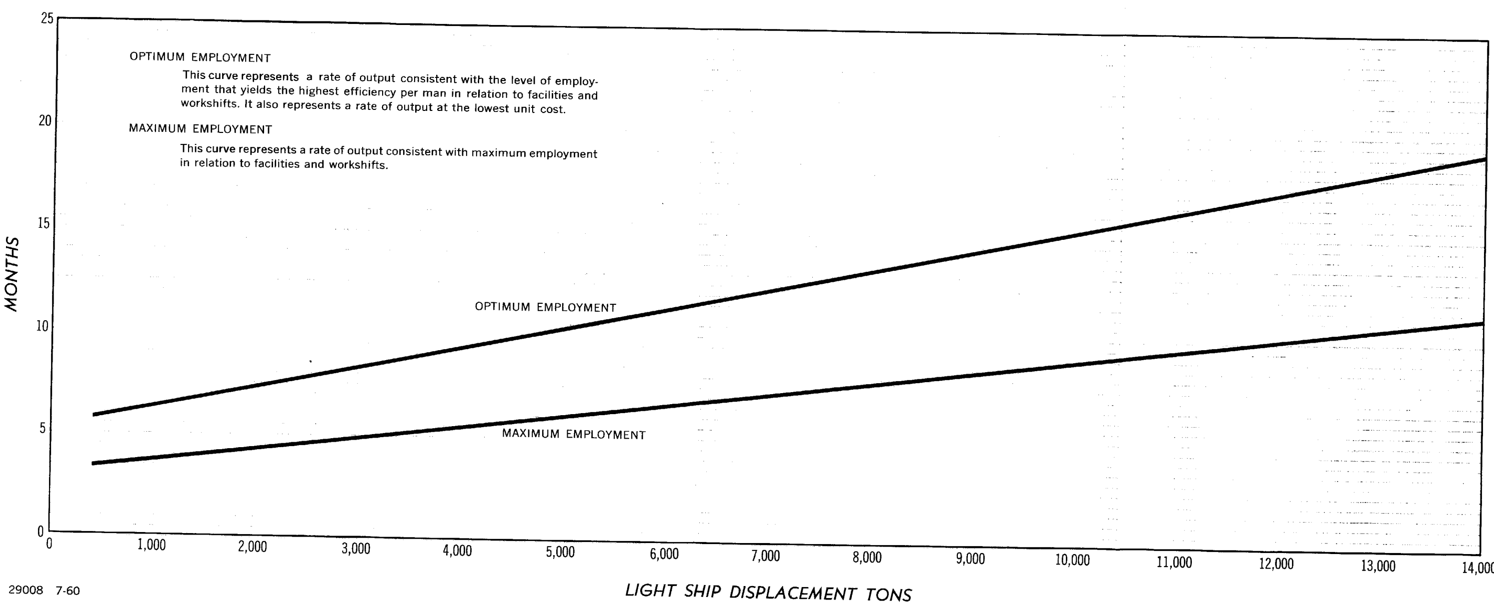
Figure 8

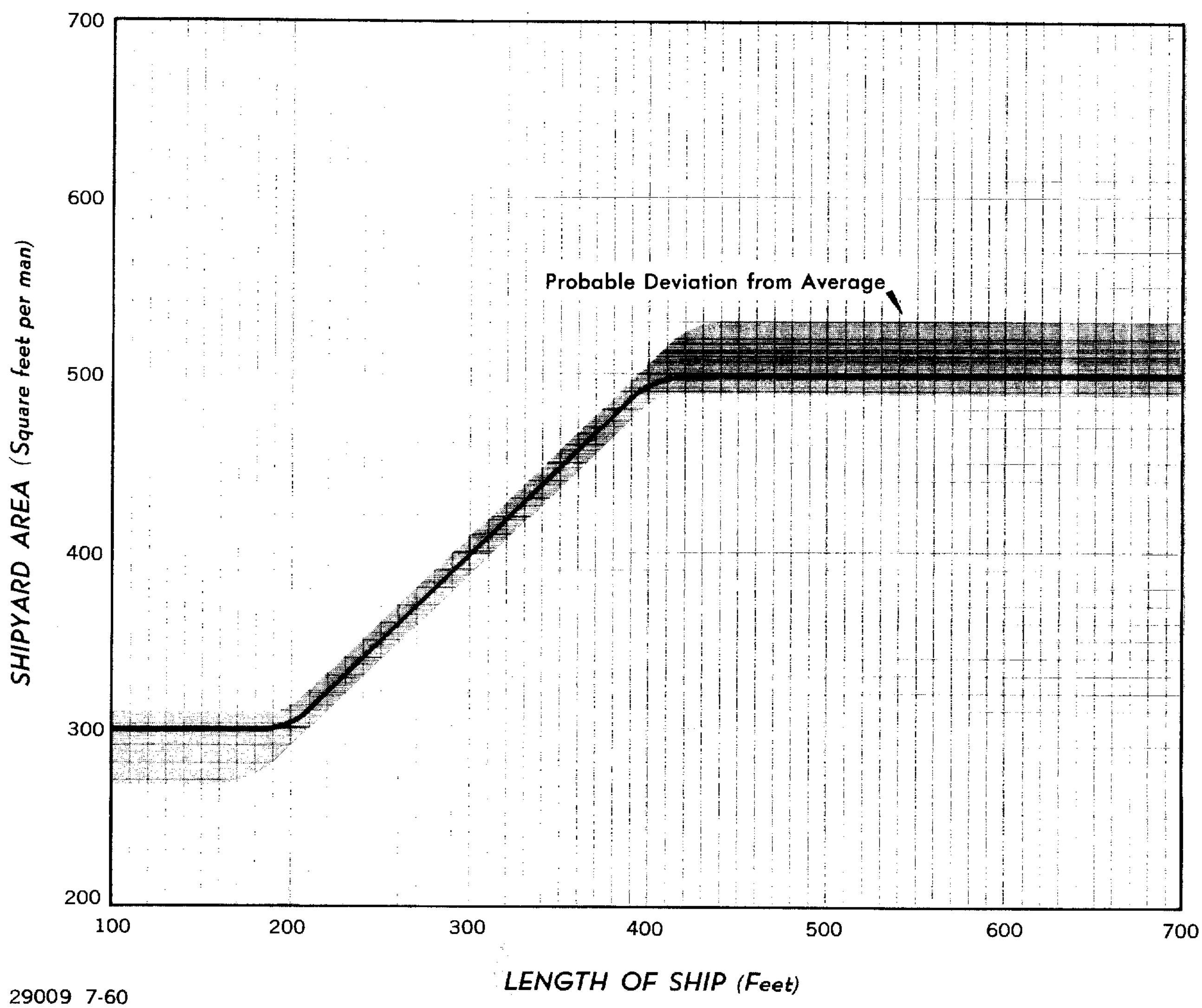
USSR: Average Construction Time in Months for Two Conditions of Shipyard Employment for Standard Cargo Ships



29008 7-60

Figure 9

Total Shipyard Area per Man



29009 7-60

APPENDIX B

ESTIMATE OF THE CAPACITY OF SHIPYARD NO. 102 AT KHERSON AND LENINSKAYA KUZNITSA SHIPYARD AT KIEV

The following examples show the practical application of each of the four methods for estimating maximum capacity. Soviet Shipyard No. 102 at Kherson was designed for the construction of large ships, and the Leninskaya Kuznitsa Shipyard at Kiev was designed for the construction of small ships.

1. Shipyard No. 102

Shipyard No. 102 at Kherson is relatively new. Construction of this shipyard was started in the late 1940's, and the shipyard was activated in the last half of 1952. It probably has the most modern equipment of any shipyard in the USSR for the construction of merchant ships. The shipyard has two ship erection sites. Each site is level and is about 1,700 ft long. The first part of each site, about 700 ft long, is covered with an open (unroofed) steel structure that supports four 50-ton bridge cranes over each ship erection site. The main hull assembly takes place under this structure. The remaining part of each site, about 1,000 ft long, has no crane-supporting superstructure. This part is used for fitting out ships and is served by four 15-ton mobile tower cranes (two at each site). Each ship erection site consists of three sets of rails on which are positioned about 32 trucks per ship -- that is, for Kazbek-class tankers. The trucks are interconnected by adjustable steel rods. On the trucks are mounted the cradles that support the ship during the whole assembly and fitting-out period. The three sets of rails extend from the covered portion of the ship erection site into the launching basin through which completed ships are lowered into the Dnieper River.

a. Shipyard Statistics

(Floor and working area in square feet)

Floor area		1,043,300
Covered storage area		101,900
Ship erection sites area, open	2,000(80) =	160,000
Ship erection sites area, covered		112,000
Outfitting quay area	860(80) =	68,800
Total		1,486,000

Number of ship erection sites	2
Length in feet of each ship erection site	1,700
Maximum length in feet of ship that can be built	575
Shipyard area in square feet	4,600,000

b. Relationship of Floor and Working Area to Maximum Output

Employees

Total maximum number of employees on the first shift	$\frac{1,486,000}{200*} = 7,430$
Total number of direct employees on the first shift	$7,430(0.75**) = 5,572$
Total number of direct employees at maximum employment for three shifts	$\frac{5,572}{0.60**} = 9,286$

One more calculation is needed in order to find the maximum annual output for a three-shift operation based on the floor and working area. Figure 4 shows that the displacement of a 575-ft cargo ship is about 8,800 LSD. Figure 5 shows that the average light ship displacement produced by one man in 1 year is 9.8 LSD.

Maximum annual output in light ship displacement for three-shift operation based on working area	$9,286(9.8) = 91,000$

c. Relationship of Methods, Time, and Ship Erection Sites to Maximum Output

Figure 8 shows that the required building time for a cargo ship of 8,800 LSD is 8.25 months. A shipbuilding technique in Shipyard No. 102 in Kherson and in similar shipyards is to move the ship along the ship erection site as the work progresses. Each ship erection site is divided into three building positions. A ship under construction is

* From Figure 3.
** See III, 1, p. 7, above.

scheduled to be moved from one position to another at regular intervals. A shorter time, usually about one-half of the time spent on one of the building positions, is required for the last position for final fitting-out and tests after launching. Therefore, in terms of time, each of the first three building positions is given a value of 1.00, and the last, or test, position is given a value of 0.50, which means that, in terms of time, a ship occupies 3.50 positions throughout the building period.

Number of months in each of the first three building positions	$\frac{8.25}{3.50} = 2.36$
Number of ships produced per year from the two ship erection sites	$\frac{12}{2.36}(2) = 10.2$
Maximum annual output in light ship displacement for three-shift operation based on ship erection sites	8,800(10.2) = 89,760

d. Relationship of Hull Steel Fabrication and Subassembly Area to Maximum Output

The shipyard's hull fabrication and subassembly area covers about 237,600 sq ft.

Finished hull steel in tons	237,600(0.27*) = 64,152
Maximum annual output in light ship displacement for three-shift operation based on hull steel fabrication and subassembly area	$\frac{64,152}{0.685**} = 93,650$

e. Relationship of Total Shipyard Area to Maximum Output

Figure 9 shows that for shipyards designed to build ships more than 400 ft long, an average of 500 sq ft should be used to estimate maximum employment on one shift.

Maximum number of direct and indirect employees that can be employed at one time	$\frac{4,600,000}{500} = 9,200$

* From Figure 6.
** From Figure 7.

Comparing employment (7,430 employees) based on working area with that (9,200 employees) based on total shipyard area shows that the latter is 24 percent greater. Output based on shipyard area and computed in the same manner as that based on working area, therefore, would show a corresponding increase, or a total output of about 112,840 LSD.

f. Conclusion

Output based on the first three methods shows a relatively small range in absolute values (minus 1 to plus 3 percent from the average), indicating a high degree of accuracy. Output based on the shipyard area is 23 percent above the average for the other three.

Because of this wide difference, an average of the first three methods, or 91,500 LSD, appears to be the best estimate of maximum annual output.

2. Leninskaya Kuznitsa Shipyard

The Leninskaya Kuznitsa Shipyard at Kiev was modernized after World War II and is an efficient shipyard for the construction of trawlers and river vessels up to 250 ft in length.

The shipyard has two principal ship erection sites, each of which is served by bridge cranes. Because of the low height of the bridge cranes, the masts and much of the superstructure on large vessels are put in place at the fitting-out quays. On the basis of the number and arrangement of the fitting-out quays and on the crane facilities over the ship erection site, it is estimated that large ships spend an equal amount of time at each position. Considering the size of the hull fabrication building, it is assumed that some subassembly work is done at the head of the ship erection sites and serviced by the same bridge cranes that are used in the final erection of the ship.

a. Shipyard Statistics

(Floor and working area in square feet)

Shop and storage area		197,100
Subassembly area		20,000
Ship erection sites area	350(30)2 =	21,000
Outfitting quay area		20,000
Total		258,100

Number of ship erection sites	2
Hull fabrication and subassembly area in square feet	56,300
Length in feet of each ship erection site (excluding subassembly area)	350
Maximum length in feet of a ship that can be built	250
Shipyard area in square feet	562,300

b. Relationship of Floor and Working Area to Maximum Output

Employees

Total maximum number of employees on the first shift	$\frac{258,100}{162.5*} = 1,588$
Total number of direct employees on the first shift	$1,588(0.75**) = 1,191$
Total number of direct employees at maximum employment for three shifts	$\frac{1,191}{0.60**} = 1,985$

One more calculation is needed in order to find the maximum annual output for three-shift operation based on the floor and working area. Figure 4 shows that the displacement of a 250-ft cargo vessel is about 1,000 LSD. Figure 5 shows that the average output by one man in 1 year is 6.4 LSD.

Maximum annual output in light ship displacement for three-shift operation based on working area	$1,985(6.4) = 12,700$

* From Figure 3.
** See III, 1, p. 7, above.

c. Relationship of Methods, Time, and Ship Erection Sites to Maximum Output

Figure 8 shows that the required building time for a cargo ship of 1,000 LSD is 3.7 months. It is assumed that an equal amount of time is spent on the ship erection site and at the fitting-out quay.

Number of months on the ship erection site	$\frac{3.7}{2} = 1.85$
Number of ships produced per year from the two ship erection sites	$\frac{12}{1.85}(2) = 13$
Maximum annual output in light ship displacement for three-shift operation based on methods, time, and ship erection site	13(1,000) = 13,000

d. Relationship of Hull Steel Fabrication and Subassembly Area to Maximum Output

The shipyard's hull fabrication and subassembly areas cover about 56,300 sq ft.

Finished hull steel in tons	56,300(0.14*) = 7,882
Maximum annual output in light ship displacement based on hull steel fabrication and subassembly area for three-shift operation	$\frac{7,882}{0.54^{**}} = 14,600$

e. Relationship of Total Shipyard Area to Maximum Output

Figure 9 shows that, for shipyards designed to build ships of about 250 ft in length, an average of 350 sq ft should be used to estimate one-shift employment.

Maximum number of direct and indirect employees that can be employed at one time	$\frac{562,300}{350} = 1,600$

* From Figure 6.
** From Figure 7.

Comparing employment (1,588 employees) based on working area with that (1,600 employees) based on total shipyard area shows that the two methods yield about the same employment. Maximum output, therefore, would be about the same.

f. Conclusion

Output based on the first three methods shows a relatively small range in absolute values (minus 5.5 percent to plus 8.7 percent from the average), indicating an acceptable degree of accuracy. An average of the first three methods, or 13,433 LSD, appears to be the best estimate of maximum annual output.

It is significant that in the instance of Shipyard No. 102 at Kherson and the Leninskaya Kuznitsa Shipyard at Kiev the highest production rate, of the first three methods, was based on output from hull fabrication and subassembly area, indicating that the shipyards probably were designed for some production other than ships to be carried on concurrently.

APPENDIX C

SOVIET CLASSIFICATION OF SHIPBUILDING ENTERPRISES, SHIPYARD PERSONNEL AND WORK-SHIFT DISTRIBUTION, HOURS AND WAGES, AND TYPES OF SHIP ERECTION SITES

1. Shipbuilding Enterprises in the USSR

According to A.S. Kreps, 5/ shipbuilding enterprises in the USSR are classified as given in the following quotation:

"The location of shipbuilding enterprises depends on the function of each type of shipbuilding enterprise. There are four types of shipbuilding industry enterprises: the yard /verf'/, shipbuilding - machine-building plant /sudostroitel'no-mashinostroitel'nyy zavod/, marine machine-building plant /zavod sudogo mashinostroyeniya/, and ship repair plant /sudoremontnyy zavod/.

"The yard type of enterprise builds ships with broad production cooperation. Ships are built in the yard through broad cooperation with other enterprises delivering all types of ship machinery. The following basic production processes are performed in the yard: ship hull construction, installation of ship equipment, and testing of the ship.

"Yards have building ways or other structures for building ships and launching them into the water (slips and ellings or covered building ways); a fitting basin; crane facilities for the building and fitting work; hull shops to work metal and handle preliminary and final assembly of the ship hull; copper pipe and ship rigging shops, fabricating portions of the piping and installing equipment on ships. To fulfill these functions, the yard must have a harbor adjoining a water basin and is therefore located in coastal areas. As a rule, maritime shipbuilding yards are located in river mouths, instead of directly on the seacoast.

"The shipbuilding - machine-building type of plant is intended to build ships with limited production cooperation. This complex type of enterprise encompasses both yard and machine-building production. Machine-building production may be varied, but such enterprises usually produce ship auxiliaries, steam boilers, ship fittings, propellers, and ship furniture. Shipbuilding - machine-building plants having a definite complex of machine-building production do not engage in such broad cooperation as yards. The shipbuilding - machine-building plant enterprise handles all the productive processes of a yard and, in addition, manufactures various types of ship equipment. It has all the buildings and shops inherent in a yard, plus the manufacturing, machine and assembling shops, and sections for the manufacture and testing of ship equipment. Because the shipbuilding - machine-building plant includes a yard, its location is determined by exactly the same conditions as that of a yard.

"Marine machine-building plants are the third type of shipbuilding industry enterprise. Their purpose is series manufacture of ship equipment. Because the Soviet shipbuilding industry has standardized ship equipment, much ship machinery, many instruments, and various fittings for ships are efficiently manufactured in large series in marine machine-building plants. Marine machine-building plants are distinguished from shipbuilding - machine-building plants, where various types of ship equipment are manufactured, because as a rule the marine machine-building plants specialize in the manufacture of one definite type of ship equipment -- for example, steam engines, ship instruments, or ship fittings. Marine machine-building plants have different site requirements and are located separately from yards in shipbuilding areas.

"The ship repair plant is the fourth type of shipbuilding industry enterprise. Its purpose is the repair and drydocking of ships. The production structure of this type of enterprise has drydock facilities; an enlarged basin; crane facilities to remove and install ship equipment; and a broad complex of manufacturing, machine and assembly shops with all-purpose types of machinery. Ship repair plants, in contrast to those enterprises which build ships, are located in ship basing areas, directly on the seacoast.

"Of the first three types of shipbuilding enterprises, the yard and the marine machine-building plant are the most efficient, economically, because they are very specialized and cooperate more extensively than the shipbuilding - machine-building plant type enterprise.

"There is no need to concentrate much machine-building production in shipbuilding enterprises, in view of the comprehensive expansion of USSR industry. Apportionment of marine machine-building among independent specialized enterprises permits series production of ship equipment and reduces manufacturing costs. This is why much machine-building for shipbuilding, which developed in prerevolutionary Russia within the shipbuilding enterprises themselves, was transferred to corresponding branches of machine building or allotted to independent marine machine-building enterprises, when Soviet shipbuilding was expanded.

"Besides the four types of enterprises already considered, there are other auxiliary types of enterprises -- the assembly yards and delivery bases.

"The assembly yard /sborochnaya verf'/ is an enterprise of incomplete profile with the functions of assembly, rigging and testing of ships, assembled from parts and equipment fabricated elsewhere. Such an enterprise does not machine hull materials or manufacture sections or blocks of the ship but receives all components of the hull, piping, systems, and installations from another shipbuilding enterprise. Assembly yards take part in the prefabricated construction of ships by completing the construction and delivery of the ship. From the location standpoint, assembly yards are similar to full profile yards.

"The delivery base /sdatochnaya baza/ is an auxiliary type of enterprise, handling the technical maintenance of ships during their test runs before acceptance. Auxiliary enterprises or affiliates of the basic shipbuilding enterprise to service ships during the test runs are needed in the testing regions because maritime shipbuilding yards and shipbuilding - machine-building plants as a rule are located in river mouths and maritime test runs are conducted under sea conditions. Delivery bases are located directly on the seacoast. Ship repair enterprises perform the functions of a delivery base in isolated cases, according to location. Special base types of enterprises are established directly on the seacoast to service ships during test runs."

2. Shipyard Personnel and Work-Shift Distribution

Generally, shipyard personnel are divided into two main categories, direct employees and indirect employees. Direct employees are those whose work is chargeable to a specific contract or work order number. This group constitutes about 75 percent of total employment in large shipyards and ranges upward to 90 percent in small shipyards. Indirect employees are those whose work, because of its broad nature, cannot practically be charged to any specific contract or work order. This group is composed of administrative, clerical, maintenance, transportation, custodial, and like personnel and comprises about 25 percent of total employment in large shipyards, ranging downward to 10 percent in small shipyards. The range in percent of indirect employees is due in part to the size of the design and order departments. Most major shipbuilding plants will have large design and order departments. Small shipyards that probably build ships from plans developed by a lead shipyard and also receive material ordered by the same lead shipyard require only a small design and order department. The determination of the estimated percentages of direct and indirect employees is a judgment factor based on the known or assumed operational practices by the shipyard under study.

According to A.M. Chelnokov's Organizatsiya i planirovaniya sudostroitel'nogo predpriyatiya (Organization and Planning in a Shipbuilding Enterprise), Leningrad, 1953, 6/ "In a shipbuilding enterprise, there are no operations which must be continued around the clock as in the case, for example, in some metallurgical plants .... The duration of the cycle of shipbuilding operations is calculated in work shifts or in work days (if the enterprise operates on two shifts)."

CPYRGHT

The number of people employed at any given time is determined by the work load and the priority status of this work load. Shift work practices in the USSR are believed to compare favorably with those in the US. Shift ratios reported in effect in the USSR in 1957 were organized on the basis of 85 percent of the direct workers on the first shift and 15 percent on the second shift. Although no percentage of workers was given for the third shift, it was reported that only machines that relieve bottlenecks are operated on this shift. It is common practice in the US under normal operating conditions to employ certain custodial and maintenance workers on the third shift. It should be noted that the shift distribution of 85 and 15 percent is a percentile distribution of current employment rather than a percentile division of the maximum possible employment. Current employment is believed to vary greatly among Soviet shipyards in relation to maximum employment or even optimum employment. Because there is practically no information on the number of workers currently engaged directly in ship construction on the first and second shifts in any Soviet shipyard, it is extremely hazardous to estimate a current rate of production based on current employment. It is equally hazardous to estimate a rate of increase above the current rate by arbitrarily assuming multiple-shift operation when undoubtedly a large increase could result first by increasing the current number of workers on the first shift.

In the US, under maximum operating conditions, an average shift distribution of direct employees is in the order of 60 percent on the first shift, 30 percent on the second shift, and 10 percent on the third shift.

Under optimum conditions, shift ratios are in the order of 82 percent on the first shift, 16 percent on the second shift, and 2 percent on the third shift. This US shift distribution compares favorably with the previously reported Soviet distribution.

3. Actual and Norm Hours and Wages

The development of a production plan in a Soviet shipbuilding industry includes a labor plan and a wage fund. It is common practice to prepare estimates of each in both the US and countries outside the Sino-Soviet Bloc, but the Soviet system for making initial calculations and executing the plan differs considerably. An understanding of the Soviet wage rate and norm hour system is necessary to determine actual labor and money inputs and to equate properly Soviet data to US data for purposes of comparison.

In the Soviet system the amount of work required by direct labor to construct a ship is divided into technical norm hours. A technical norm hour denotes an established amount of work to be performed in a fixed period of time.

Technical norms are of the following two types: (a) technical time norms, which denote the time established for the performance of a task under certain organizational technical conditions and with the fullest utilization of all means of production, and (b) technical output norms, which denote the number of production units that must be obtained under the same condition per unit time.

According to Kreps, 7/

> "technical norms take into account advanced technological methods and the practices of production innovators. The establishment of technical norms is a major factor in the rational organization of labor. The technical norm system is used to study and regulate a given technological process, to introduce rational working methods into production, to identify foremost production workers, and to organize socialist competition. Because production conditions and the nature of the equipment, tools, attachments, and operating speeds are not constant but, on the contrary, change all the time with greater mechanization and automation, the technical norms must of course be reviewed periodically."

Wages are based on the technological complexity of the technical norms. Because of the wide range in skills required to construct a ship, the skills of workers for purposes of wage determination are divided into eight wage grades. Two forms of wages are used -- piece work and time work.

Piece work is the principal form, and in this system the amount of wage is the product of the piece-work rate, previously fixed for a unit of output, and the actual number of units of output produced. The time-work wage system is based on the time worked and the worker's skill.

The piece-work wage system is used in Soviet shipbuilding in the form of individual piece-work and team piece-work. In individual piece-work the earnings of each worker are based on the percent of norm fulfillment and not on the number of actual hours worked. In team piece-work the earnings of the entire team are determined in the same fashion, and the pay distribution within the team is based on rating coefficients -- that is, on the degree of skill and amount of time put in by each worker.

In the Soviet calculation of labor input in a production plan, a shipbuilding enterprise is considered to be in operation from 300 to 307 working days per year. The actual number of hours worked by an individual within a year varies according to the individual's occupation and longevity. According to Chelnokov, 8/

"The regular vacation given workers is 12 working days. Three more vacation days are given to persons engaged in production and working in the given plant more than 2 years; 6 more days are given to persons engaged in heavy work (for example, electric welders); 12 more days are given to persons engaged in harmful and dangerous work (for example, benders of hot plates); 10 additional days are given for examination purposes each year to those studying while working full time in higher and specialized learning institutions.

"Maternity leave amounts to 77 calendar days. The initial data for planning these leaves and interruptions for breast feeding of children are the accounting data for the preceding year, taking into account the annual increase in the birth rate in the USSR.

"Government service obligations, for which the worker is paid in accordance with his average wages, are established by labor law such as service as a delegate, participation in trial meetings, participation in conferences and plenums on the rayon level or higher, participation in draft board commissions and assemblies, and participation of volunteer firemen in actual extinguishing of fires."

Kreps 9/ indicates that, for purposes of estimating, the average annual time budgeted to each worker is 2,400 actual hours less 12 percent, or 288 actual hours, for vacations, official time off, sick leave, absenteeism and the like, which results in an average of 2,112 actual effective working hours per worker. Because the amount of work required by the plan for annual production has been calculated in the form of norm hours, the number of workers required to complete the plan is based on an average fulfillment of 130 percent of the norm hour plan -- that is, 10.4 norm hours of work are to be completed by one worker in 8 actual hours. Therefore, for purposes of estimating, one worker is required for each 2,745 norm hours, in the current labor plan, for annual production.

4. Types of Ship Erection Sites

a. Inclined Erection Sites and Fitting-Out Quays

Ships erected on inclined ways usually are assembled from preassembled subassemblies and launched when the ship is about 65 percent complete. The ship is completed and dock trials are held at the fitting-out quay. When only one ship is erected at one time on the ship erection site, the ship is moved through two positions (one at the erection site and one at the fitting-out quay). An equal amount of time usually is spent in each position. When a ship erection site is long enough to permit the simultaneous construction of one and one-half ships, Soviet practice has been to build one-half of a ship at the head of the site, and on launching another ship under construction at the foot of the site, to move the one-half ship to the foot and complete it while another half-ship is being constructed at the head of the site. In this practice, three building positions are used, and an equal amount of time is spent in each of the three positions.

b. Floodable Shipbuilding Docks and Fitting-Out Quays

Little information is available on this type of assembly. It is believed that a ship is assembled from subassemblies and is about three-fourths complete on launching. Because the time spent at the fitting-out quay is considerably shorter than the time spent in the dock, a total of one and one-third building positions is assumed.

c. Level Ship Erection Sites and Fitting-Out Quays

Ships built on level, or horizontal, ship erection sites are either launched by moving the ship into a floodable basin, launched transversely by controlled means, or launched by a vertical ship hoist or a floating launching dock. The size of the launching facility determines the maximum size of ship that can be built on the level ship erection site, although the site may be several times the length of the permissible ship.

For ships that are to be assembled from subassemblies, it is necessary to know or estimate the number of building positions on the level ship erection site. Because these ships usually are about 95 percent complete on launching, a much shorter time is spent at the fitting-out quay than at any one of the building positions on the level ship erection site. Therefore, the number of positions through which the ship moves is the total number of positions on the level ship erection site plus the one-half position at the quay.

For ships that are to be assembled from structural regions, it is assumed that the assembly of the structural regions constitutes one building position. The joining together of these structural regions on the ship erection site may occupy one or more building positions. Ships launched from the ship erection sites are essentially complete, and the time required at the fitting-out quay is roughly one-half of the time required at any one position before launching. Therefore, the number of building positions is the sum of the following: one during the assembly of structural regions, one or more on the erection site, and one-half at the fitting-out quay.

APPENDIX D

SOURCE REFERENCES

Evaluations, following the classification entry and designated "Eval.," have the following significance:

Source of Information	Information
Doc. - Documentary	1 - Confirmed by other sources
A - Completely reliable	2 - Probably true
B - Usually reliable	3 - Possibly true
C - Fairly reliable	4 - Doubtful
D - Not usually reliable	5 - Probably false
E - Not reliable	6 - Cannot be judged
F - Cannot be judged	

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

Evaluations not otherwise designated are those appearing on the cited document; those designated "RR" are by the author of this research aid. No "RR" evaluation is given when the author agrees with the evaluation on the cited document.

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1. CIA. FDD U-3,054,766, 23 Sep 57, p. 1-70. OFF USE. Eval. Doc.
2. CIA. FDD Translation no 626, 1 Mar 57, p. 10-12, 22-29, 35-36, 106-109. OFF USE. Eval. Doc.
3. CIA. FDD U-3,054,766, 23 Sep 57, p. 1-70. OFF USE. Eval. Doc.
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5. CIA. FDD Translation no 626, 1 Mar 57, p. 10-12, 22-29, 35-36, 106-109. OFF USE. Eval. Doc.
6. CIA. FDD Translation no 593, 18 Sep 56, p. 26, 358, 180, 181. OFF USE. Eval. Doc.

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